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PRE-ASSEMBLED INTERNAL SHEAR PANEL

Background of the Invention

Field of the Invention

The present invention relates to an apparatus for reducing the risk of damage to buildings as a result of lateral forces applied to the building and, in particular, concerns a pre-assembled internal shear panel that can be installed into a building wall to reduce the risk of the building wall becoming dislodged from the foundation as a result of lateral forces such as those generated in earthquakes and high winds.

Description of the Related Art

In typical building construction the walls are comprised of a frame that is anchored to the foundation and a covering that is installed onto the frame. Typically, the frame of a building has a number of vertically extending studs that are positioned between an upper and a lower plate. The lower plate is typically anchored to the foundation and the covering material, e.g., plywood, siding and the like, is then nailed to the studs.

One problem that occurs in buildings is that lateral forces applied in a direction parallel to, and in the plane of, the wall can cause the upper section of the wall to move relative to the lower plate which is anchored to the foundation. These forces often occur as a result of natural phenomenon such as high winds and earthquakes. It will be evident that too much movement of the upper sections of the wall relative to the anchored lower plate can result in damage to the frame of the wall which can further result in the wall collapsing.

To address this particular problem, buildings are often equipped with a lateral bracing system. One type of lateral bracing system is known as shear panels that are installed in the walls to stiffen the structure against racking or deformation in the plane the walls. For example, in the

2

typical residential building, wherein the frames are primarily constructed of wood, plywood sheathing is attached to three or more of the studs, and to the upper and lower plate of the wall, to inhibit the movement of the upper portion of the wall in response to these lateral forces. Specifically, the end studs of the shear panel or posts are typically fastened to a heavier anchor bolt, known as a holdown bolt, at a position adjacent to the end posts by means of various hardware types known as holdowns. The plywood, which forms a vertical diaphragm, is attached to the upper plate and the lower plate of the wall, and also to the posts with specified boundary fasteners such that the shear force is transmitted through the diaphragm to end posts, the holdown device, and bolt. Hence, the tendency of the upper portion of the wall to move relative the lower portion of the wall as a result of the shear forces is reduced. Basically, the plywood diaphragm creates diagonal braces that inhibit movement of the upper portion of the wall relative to the lower portion.

These shear panels are typically built in the field during the construction of the building. It will be appreciated that constructing these structures in the field can be time consuming and can also result in construction errors that will affect the strength of the wall.

Further, these types of shear panels and, in particular, the plywood shear panels used in wooden framed buildings, must be comparatively large to withstand the significant amount of lateral forces that are generated in large earthquakes. For example, most building codes limit the story drift or lateral deformation to 1/4" for an 8' wall height in all types of buildings. The ratio of the height of various shear panels to their width is also limited by the building code depending on the type of sheathing material used. To achieve this limitation on story drift in response to this applied lateral force, the shear panel must generally include a plywood diaphragm that is on the order of 2 to 4

feet in length. While on long walls there may be the space available between openings to position a 4-foot long or greater shear panel, in smaller buildings with smaller lengths of walls, there is often no room to construct a shear panel of this size. Further, it will be appreciated that multiple story buildings are more susceptible to larger lateral forces often necessitating even larger lateral bracing structures. This exacerbates the problem of a limited amount of space in walls of smaller lengths.

Hence, there is a need for a shear panel which is easy to install and is comparatively small in size so that it can be readily installed in walls having shorter lengths. To this end, there is a need for a prefabricated shear panel that is capable of ready installation into and between the studs of walls wherein the shear panel is capable of minimizing the movement of the upper portion of the wall relative to the lower portion to within an acceptable amount.

Summary of the Invention

The aforementioned needs are satisfied by the pre-assembled internal shear panel apparatus of the present invention which is comprised of two side members, or vertical posts that are spaced apart, and at least one diaphragm member that is positioned between, and connected to, the two side members. Further, there is an upper and lower member that is connected to the side members and the diaphragm member so as to form a rigid structure.

The lower member is positioned within a bracket member that is configured to be attached to a holdown bolt that is anchored in the foundation. There are two bracket members, one on each end, which are attached to one of the posts and both of the bracket members are also respectively connected to holdown bolts that are anchored in the foundation of the building.

The side, top and bottom members of the shear panel are all attached to form a preferably rectangular frame of which the upper member of the panel is connected to an upper plate

of the wall. This results in a shear panel capable of opposing lateral forces in the plane of the wall so as to reduce movement of the upper plate of the wall with respect to the lower plate.

In one preferred embodiment, the posts are formed out of a plurality of light gauge steel members and there are two sheets of sheet steel forming a diaphragm that are attached to both of the posts substantially along the full length of the posts and to the top and bottom frame members, with one sheet on each side of the frame. Further, there is preferably at least one reinforcing member which interconnects the posts positioned between the upper and lower member and between the two sheets forming the diaphragm members. The reinforcing member stiffens the side members and reduces the tendency for the steel sheets to buckle when the shear panel is under load.

The shear panel of the preferred embodiment is attached at the bottom corners to holdown bolts which are anchored in the foundation of the building and the bottom member of the steel frame is fastened to the concrete foundation with a minimum of two anchor bolts or approved fasteners. The upper member of the shear panel of the preferred embodiment is connected to the upper plate of the frame of the wall so that lateral forces in the plane of the wall are transmitted to the shear panel. Because the lateral force is applied through the top plate there is an overturning effect on the panel that is resisted by the end posts, holdown assembly and anchor bolts. The horizontal shear force is resisted by the additional anchor bolts or fasteners in the bottom frame members. In one preferred embodiment, a gusset is used to attach the upper member of the shear panel to the upper plate of the frame of the wall. Further, in the preferred embodiment additional shear bolts are mounted through the lower member of the shear panel into the foundation of the building to reduce the likelihood that the shear panel will

become dismounted at the bottom end from the foundation as a result of shear forces applied against the wall.

The shear panel of the preferred embodiment is preferably shipped to the job site substantially assembled. The installer simply has to attach the mounting brackets to the holdown bolts that are anchored in the foundation and then position the lower member of the shear panel in the brackets. Subsequently, the installer has to secure the lower member of the shear panel to the brackets, and, hence, to the concrete foundation with cast-in-place anchor bolts or other approved fasteners. Subsequently, the remainder of the shear panel can be attached to the lower member. Further, the upper member of the shear panel can then be attached to an upper portion, e.g., the upper plates, of the wall. Hence, installation of the shear panel of the preferred embodiment is simplified over constructing an appropriate shear panel in the field during the construction of the building.

In addition, the configuration and metal construction of the shear panel of the preferred embodiment results in a shear panel that is capable of withstanding greater amounts of shear forces than the shear panel structures of the prior art. This allows the shear panel of the preferred embodiment to be smaller in size, e.g., have a smaller width, which allows the shear panel to be installed along smaller wall sections without a decrease in the amount of protection against lateral forces. These and other objects and features of the present invention will become more fully apparent from the following description and appended claims taken in conjunction with the accompanying drawings.

Brief Description of the Drawings

Figure 1 is a perspective view of one preferred embodiment of a shear panel;

Figure 2A is an exploded perspective assembly view of the shear panel shown in Figure 1;

Figure 2B is an exploded perspective assembly view of another embodiment of the shear panel shown in Figure 1;

Figure 2C is an exploded perspective assembly view of another embodiment of the shear panel shown in Figure 1;

Figure 3A is a sectional view of the shear panel shown in Figure 1 taken along the line A-A, in Figure 1;

Figure 3B is a sectional view of the shear panel shown in Figure 1 taken along the line B-B, in Figure 1;

Figure 4A is a sectional view of the shear panel of Figure 1 taken along the lines D-D in Figure 1;

Figure 4B is a sectional view of the shear panel of Figure 1 taken along the lines C-C in Figure 1;

Figure 5 is an elevation view of the shear panel of Figure 1 installed in a one-story wall of a building having wooden framing;

Figure 6 is an elevation view of the shear panel of Figure 1 that is modified so as to be installed in a one-story wall having steel framing; and

Figure 7 is a partial elevation view of two shear panels of Figure 1 installed on a two-story building.

Detailed Description of the Preferred Embodiment

Reference will now be made to the drawings wherein like numerals refer to like parts throughout. Figure 1 is a perspective view of a shear panel 100 of the preferred embodiment that is used to reduce the relative motion of an upper section of a wall relative to a bottom section of a wall in response to lateral forces that project in a direction along the length of the wall. The construction of the preferred embodiments of the shear panel 100 will initially be described in reference to Figures 1 - 4 and the installation and operation of the shear panel 100 of the preferred embodiments will be described in reference to Figures 5 - 7.

Referring initially to Figure 1, a shear panel 100 of the preferred embodiment is shown. Figure 1 illustrates the preferred configuration of the shear panel 100 in an

assembled form as it is shipped to the building site. The shear panel 100 includes two vertical or side posts 102a and 102b that preferably extend the height of a wall (not shown). Typically, in most residential construction, wall heights are either 7'-8" tall or 10' tall. The vertical posts 102a and 102b are thus approximately either 7'-8" or 10' tall depending upon the application. It will be appreciated from the following description that walls having different heights may also be braced using the shear panel of the present invention. For example some gables and walls having a pitch at the top equivalent to the roof pitch of the structure may be even higher than 10'. The shear panel of the preferred embodiment can be installed in these applications as well, necessitating the use of a 10' high panel.

The side posts 102a and 102b at their upper ends 103a and 103b respectively, are connected to a horizontal upper member 104. Similarly, the vertical posts 102a and 102b are connected at their respective lower ends 105a and 105b to a horizontal lower member 106. The interconnection between the posts 102a and 102b and the upper and lower members 104, 106 respectively is described in greater detail hereinbelow in reference to Figures 3A and 3B. which forms a brace member for opposite 100

Further, at least one diaphragm member 110 extends between the vertical posts 102a and 102b substantially along the entire height of the vertical posts 102a and 102b and is also connected to the upper member 104 and the lower member 106. As will be described in greater detail hereinbelow, the diaphragm member serves to transmit a force in opposition to force exerted on the upper member 104 to the lower member 106.

Figure 2A illustrates the construction of the components of the shear panel 100 in greater detail. Specifically, the vertical post 102a in this embodiment is comprised of an inner retaining member 114 wherein two reinforcing members 116a and 116b are positioned inside of the inner retaining member 114. In the preferred embodiment, the inner retaining

8

member 114 is comprised of a piece of U-channel where the opening to the U-channel faces outward and the two pieces of reinforcing member 116a and 116b are comprised of two pieces of Cee-channel that are configured to be positioned within the inner retaining member 114 in the manner shown in Figure 3A.

As is also shown in Figures 2A and 3A, the two pieces of reinforcing Cee-channel 116a and 116b are positioned in the top portion of the inner retaining member 114. However, as shown in Figure 3B, in the bottom portion of the inner retaining member 114, there is a piece of reinforcing tube 126 that is stronger than the reinforcing members 116a and 116b. In the preferred embodiment, the reinforcing tube 126 is comprised of 8-inch thick steel tubing that is approximately 6" long and 2" x 3" in cross-section, which provides greater structural support for the bottom portion of the vertical posts 102a and 102b to minimize the tendency of the vertical posts 102a and 102b to bend in response to lateral forces applied to the upper portion of the shear panel 100. It will be appreciated that the Cee-channel reinforcing members can be replaced by the 1/8-inch thick steel tube along the full length of the inner retaining member 114 without departing from the spirit of the present invention.

In the preferred embodiment there are two diaphragm members 110a and 110b which are preferably comprised of sheet steel wherein each of the diaphragm members 110a and 110b have a lip 122 formed on a side of the diaphragm member 110. Preferably, as shown in Figure 3A, the lip 122 has approximately the same width as the opening on the U-channel comprising the inner retaining member 114. In the preferred embodiment, the diaphragm members 110a and 110b are positioned immediately adjacent the inner retaining member 114 so that the lip 122 on one of the diaphragm members 110a and 110b is positioned in front of an opening 115 to the U-channel comprising the retaining member 114. An outer

retaining member 120 is then positioned adjacent the diaphragm members 110a and 110b. In the preferred embodiment, the outer retaining member 120 is comprised of a length of U-channel member having an opening 121 that is slightly larger than the width of the inner retaining member 114 and the thickness of the two diaphragm members 110a and 110b.

Hence, the post 102a is comprised of an inner retaining member 114 that is reinforced by the reinforcing members 116 and the tube 126 positioned therein. The diaphragm members 110a and 110b are then positioned adjacent the inner retaining member 114 and captured within the outer retaining member 120.

As shown in Figures 1 and 3A, fasteners 124 are positioned along the entire height of the vertical posts 102a and 102b to securely interconnect the inner retaining member 114, the reinforcing members 116, the diaphragm members 110a and 110b and the outer retaining member 120. In the preferred embodiment, the fasteners 124 are comprised of screws wherein two screws are placed at approximately 4-inch intervals along the entire length of the vertical posts 102a and 102b between the upper member 104 and the lower member 106.

The foregoing description has described the preferred construction of the vertical post 102a, it will be appreciated that the vertical post 102b is constructed in an identical fashion as the vertical post 102a. Figures 2B and 2C illustrate alternate embodiments of the shear panel 100. In particular, Figure 2B illustrates a diaphragm member 110a' and 110b' having lips 122' extending along both of the outer edges of the panels 110a' and 110b'. Similarly, Figure 2C illustrates a diaphragm member 110b'' having a lip 122', like the lip shown in Figure 2b, may be used in combination with a diaphragm member 110a'' that has a lip 122'' which extends perpendicular to the plane of the member and then parallel to the plane of the member, thereby having a generally U-shaped

cross-section may also be used to securely interconnect the diaphragm member to the vertical posts. It will be appreciated that any number of different methods of interconnecting the diaphragm members to the posts may be used without departing from the spirit of the present invention.

As is also shown in Figure 2A, the upper member 104 and the lower member 106 are comprised of a U-channel that has a width which is approximately equal to the width of the outer retaining member 120 of the vertical posts 102a and 102b. As is shown in Figures 2A and 4B, the upper member 104 has a U-shape cross-section with an opening 146 wherein the upper end 103a of the post 102a is positioned within the opening 146. A plurality of fasteners 124 are then used to interconnect the post 102a to the upper member 104. In the embodiment shown in Figure 3B, the fasteners are comprised of screws. Further, the diaphragm members 110a and 110b are also positioned inside of the opening 146 of the upper member 104 and are attached, via screws, across the length of the upper member 104 in the manner shown in Figure 1.

The lower member 106 is also comprised of a piece of U-channel that has an opening 148 that is substantially equal to the thickness of the outer retaining member 120 of the vertical post 102a and 102b to thereby allow the vertical posts 102a and 102b to be positioned within the lower member 106 and secured thereto. In the embodiment shown in Figures 1 and 2, there are two brackets 130a and 130b that have openings for bolts that are configured to fit around the outer walls of the lower member 106. As is shown in Figure 1, the brackets 130a and 130b are mounted on the lower member 106 at the position where the vertical posts 102a and 102b are positioned within the lower member 106. A plurality of heavy duty fasteners 132, which in this embodiment are comprised of three bolts, are then screwed entirely through the brackets 130a and 130b, the lower member 106 and the vertical posts 102a and 102b to thereby securely attach the

posts 102a and 102b to the brackets 130a and 130b respectively, in the manner shown in Figure 4A.

As is also shown in Figure 2A, there are two reinforcing members 140 that interconnect the vertical posts 102a and 102b. Specifically, the reinforcing members 140 are preferably comprised of pieces of U-channel which are connected to the inner retaining member 114 on each of the vertical posts 102a and 102b. Preferably the reinforcing members 140 are positioned approximately 1/3 of the way from the top and the bottom of the shear panel 100.

In one preferred embodiment of the shear panel of the present invention, the reinforcing members 116 are comprised of two pieces of Cee-channel that is 1-1/2" x 2" wide, 18 gauge and approximately 7'-2" or 9'-6" in length. The inner retaining member 114 is comprised of 2-7/8" x 2-1/4" U-channel that is 18 gauge and is 7'-8" or 10' long depending upon the embodiment of the shear panel that is being fabricated. The diaphragm members 110a and 110b are preferably comprised of a sheet of 18 gauge steel that is 7'-8" or 10' long depending upon the application and 2' wide wherein the sheet is bent along one edge to form a 2" lip. The outer retaining member 120 is preferably comprised of 18 gauge U-channel that is 3" x 2" in cross-section and is either 7'-8" long or 10' long depending upon the application. The upper and bottom members 104 and 106 are comprised of 18 gauge U-track that is 5-13/16" x 2-3/8" in cross-section and is 1'-10" in length. The brackets 130a and 130b are preferably comprised of 1/8" thick steel that is 6-1/2" in height, 2-9/16" in width and 3" long. Further, along the side walls of the bracket there are three 1/2" holes drilled on both of the side walls. Further, there is a 2-9/16" x 3" x 1/2" thick plate 150 welded to the bottom of the bracket with a 1" hole in the center and 1/8" chamfers along the lower 3" edges.

The installation and operation of the shear panel 100 will now be described in reference to Figures 5 - 7. Figure

5 illustrates how the shear panel 100 is installed in a single story wall 168 of a building. In particular, the shear panel 100 is installed so as to extend between two of the vertical studs 160a and 160b of the wall. While in the preferred embodiment the shear panel is not directly attached to these studs 160a and 160b but is inset inside of them, it will be understood, however, that the shear panel 100 may, in some circumstances, be attached to the studs 160a and 160b using suitable fasteners to further enhance the ability of the wall to withstand shear forces.

The shear panel 100 is connected to an upper plate 162 of the wall structure, which in this embodiment is comprised of two 2" x 4" boards, via a gusset 164 in the manner shown in Figures 4B and 5. The gusset 164 is connected both to the upper plate 162 and to the upper member 104 of the shear panel 100 through the use of nails, screws, or other fasteners. In the preferred embodiment, a multiplicity of wood screws 152 (Figure 4B) is used to securely fasten the gusset 164 to the upper plate and a plurality of fasteners 124 is used to connect the gusset 164 to the upper member 104 of the shear panel 100.

At the lower end of the shear panel 100, the brackets 130a and 130b, are mounted over two holdown bolts 166a and 166b that are anchored in the foundation 170 of the building. The holdown bolts 166 can either be previously anchored into the foundation 170 or they can be retrofitted into the foundation in the desired location using well-known methods. Generally, the holdown bolts 166 stub up through the upper surface of the foundation 170 and the brackets 130a and 130b can be positioned over the holdown bolts with the bolts extending through an opening 133 (Figure 4A) in the bottom of the bracket 130a and 130b. The brackets 130a and 130b can then be securely fastened to the holdown bolts 166 by tightening a nut 135 (Figure 4A) on top of the bolts against the reinforcing plate 150 on the bottom surface of the brackets 130a and 130b.

Subsequently, the lower member 106 can then be installed in the bracket and the vertical posts 102a and 102b can then be positioned within the lower member 106 at a position adjacent the brackets 130a and 130b so that the bolts 132 can be installed through the brackets 130a and 130b, the lower member 106 and the posts 102a and 102b to secure the posts 102a and 102b to the brackets 130a and 130b and thereby anchor the vertical posts 102a and 102b and the diaphragm members 110a and 110b forming the panel 100 to the foundation.

It will also be appreciated that it may be desirable to attach the shear panel 100 to one or more shear bolts 172 that are previously mounted in the foundation 170. The shear bolts 172 stub up out of the foundation 170 and holes can be drilled in the lower member 106 so that the lower member 106 can be positioned over the shear bolts 172 and then attached to the shear bolts via nuts. Further, it will be appreciated that spacers 174 (Figure 5) may preferably be positioned between the foundation 170 and the bottom surface of the lower member 106 in order to ensure that there is adequate attachment between the lower member 106 and the shear bolts 172 mounted in the foundation 170. As is also shown in Figure 5, the bottom plate 161 between the studs 160a and 160b is preferably removed prior to installation of the shear panel 100.

From the foregoing description, it will be understood that the shear panel 100 of the preferred embodiment is easy to install in the wall of a building. Specifically, the builder of the wall simply has to ensure that the holdown bolts 106 and the shear bolts 172 are positioned so as to be substantially co-planar with one of the two outer edges of the upper plate 162 of the frame. Subsequently, the brackets 130a and 130b can then be mounted on the holdown bolts in the previously described fashion and the lower member 106 can be connected to the shear bolts and positioned within the brackets 130a and 130b.

Subsequently, the remainder of the shear panel 100 can be installed in the lower member 106 and the bolts 132 can be installed to connect the vertical post 102a and 102b to the lower member 106 and the brackets 130a and 130b. Further, screws 124 along the lower member 106 can then be installed to interconnect the lower member 106 to the diaphragm members 110a and 110b. Once the shear panel 100 is connected to the foundation, the gusset 164 can then be connected to the upper member 104 and the upper plate of the wall. In the preferred embodiment, the shear panel 100 will preferably be shipped to the job site in substantially the configuration shown in Figure 1 and the workers will then detach the brackets 130a and 130b and the lower member 106 for installation to the foundation in the previously described manner.

It will be appreciated that installation of the shear panel 100 on the wall 168 reduces the tendency of the upper portion 180 of the wall 168 to move with respect to the foundation 170. Specifically, the arrows 182 and 184 are representative of lateral forces that are directed parallel to the length of the wall 168. It will be appreciated that when a lateral force in the direction of the arrow 182 is applied to the wall 168 the upper portion 180 of the wall 168 will have a tendency to pivot about the left-most holdown bolt 166a. However, the force in the direction of the arrow 182 is opposed by an equal and opposite force exerted on the right bottom corner of the shear panel 100 by the holdown bolt 166b thereby reducing the tendency of the shear panel to overturn. The shear bolts 172 prevent the panel and wall 168 from sliding in the direction of the arrow 182.

Basically, the gusset 164, the upper member 104, the diaphragm members 110a and 110b and the posts 102a and 102b provide a diagonally braced frame in each direction of the arrow 186 in Figure 4 which reduces the tendency of the upper portion 180 of the wall to move in the direction of the arrow 182. Similarly, when a shear force is directed parallel to the length of the wall 168 in the direction of the arrow 184,

the gusset 164, the upper member 104, the diaphragm members 110a and 110b and the posts 102a and 102b serve as a diagonal brace in the direction of the arrow 188 with the left-most holdown bolt 166a to oppose the tendency of the shear panel to overturn and the wall 180 to move in the direction of the arrow 184.

Hence, the shear panel 100 opposes the movement of the wall in directions which are parallel to the length of the wall and in the plane of the wall and, based upon pseudo-cyclic testing performed at the University of California, Irvine, in Irvine, California, a shear panel having the configuration of the preferred embodiment of the shear panel 100 is capable of withstanding up to 3500 lbs. of load applied to the upper portion 180 of a 7'-8" wall structure 168 while only having the upper portion of the wall deflect approximately 1/2" or less from its normal resting position.

Essentially, the shear panel 100 preferably functions like a large vertical cantilevered girder fixed at the bottom and loaded horizontally in the plane of the panel at the top member. The diaphragm members 110a and 110b resist the shear forces and the flanges of the girders are comprised of the post assemblies 102a and 102b which resist the axial stress due to bending. Preferably, the brackets 130a and 130b and the holdown bolts 166 are sized to withstand the uplift force generated by the overturning moment of the panel 100 when exposed to forces in the direction of the arrows 182 and 184, i.e., horizontal forces, and the shear bolts 172 are sized to resist the horizontal shear force. The reinforcing members 140 serve the purpose of reducing the tendency of the diaphragm members 110a and 110b to buckle under the loads generated by the shear forces. It will be appreciated that the shear panel 100 of the preferred embodiment is thus very easy to install and is capable of withstanding significantly more shear forces than the shear panels that are currently used in residential and business construction.

Figure 6 illustrates a modified version of the embodiment of the shear panel 100' wherein the shear panel 100' is configured to be installed in a steel framed wall 168'. It will be understood that both wood framed walls and steel framed walls are currently used in standard construction techniques and that the shear panels 100 and 100' can be used equally well with either type of construction. The only difference in the shear panel 100' from the shear panel 100 is that the dimensions of the shear panel may change as a result of the differences in framing spaces in the steel frame wall 168 and that the upper member 104 of the shear panel 100' can be bolted or screwed directly to a steel upper plate or track 162' of the wall 168' thereby avoiding the need of a gusset. Hence, it will be appreciated that the shear panel of the present invention can be installed equally well on both wood framed and steel framed walls and that the exact dimensions and configuration of the shear panel will, of course, vary depending upon the spacing of the studs in the wall and the height of the wall.

Figure 7 illustrates how two shear panels 100 of the preferred embodiment can be used to provide shear protection for two-story walls. In particular, two shear panels 100 are installed in the two-story wall 190 with the lower shear panel 100a being installed in the exact same manner as described before with reference to Figure 5. The upper shear panel is attached to an upper plate 192 of the two-story wall 190 with a gusset 164 ~~162~~ in the same manner as described before in reference to Figure 5. At the bottom end, the vertical posts 102a and 102b and the lower member 106 are not positioned within brackets 130a and 130b but, in fact, are attached to metal straps 194, via the bolts 132, that are then connected to the upper member 106 of the lower shear panel 100. The bolts 132 are preferably connected to the posts 102a and 102b of the upper panel 100b in the same manner as described above in reference to Figure 4A.

Further, a gusset 164 ~~162b~~ can also be used to attach the lower member 106 of the upper shear panel 100 to a floor space ~~lower~~ member 200 ~~plate 196~~ of the two-story wall 190. The straps 194 firmly connect the bottom portion of the upper shear panel 100b to the top portion of the bottom shear panel 100a so that the upper panel 100b is anchored to the lower panel 100a across the floor space member 200 between the two stories of the wall.

Further, the lower gusset 164 ~~162b~~ further reduces the tendency of the upper portion of the second story of the wall 190 to move with respect to the lower plate 196 of the second story of the wall as the shear panel is connected along its entire width to the floor member 200 ~~lower plate 196~~ of the second story of the wall via the lower gusset 162b. Since the lower shear panel 100a ~~100b~~ is attached to the foundation in the manner described above in reference to Figure 5 and since the upper panel 100b is attached to the lower panel 100a via the straps 194, movement of the upper portion 190 of the second story of the wall 190 as a result of lateral forces being applied in a direction parallel to the wall, i.e., in the direction of the arrows 182 and 184, is reduced.

It will be appreciated that the previously described preferred embodiments of the shear panels are easy to install as a result of their prefabrication and provide excellent protection against shear forces that are acting in a direction parallel to the length of the wall. Specifically, the shear panel of the present invention uses two reinforced posts with an interconnecting diaphragm member to transfer the forces, resulting from a shear force being applied against the wall, to the holdown bolts that are embedded in the foundation. Since the panel is largely pre-fabricated, the worker simply has to connect the panel to the upper plate of the wall and then connect the lower portion of the panel to the holdown and shear bolts mounted in the foundation. Hence, it is simpler for the construction worker to install the shear panel and, since the panel is pre-fabricated, the possibility of field installation error, which would increase

the probability that the panel would not perform as intended, is of course reduced.

Further, since reinforced posts are used in conjunction with metal diaphragm sheets, the amount of shear force that can be transferred to the holdown bolts is increased. Specifically, using the shear panel constructed in the manner as the shear panels of the preferred embodiment, a shear panel that is only two feet in width can be used in the place of a shear panel structure fabricated out of plywood and the like that is over four feet in length. Hence, shear panels constructed according to the teachings of the preferred embodiment, e.g., with reinforced metal posts and with metal diaphragm members, can be used to provide protection against movement of the upper portions of walls relative to the foundations for walls that are short in length.

Although the preferred embodiment of the present invention has shown, described and pointed out the fundamental novel features of the invention as applied to these embodiments, it will be understood that various omissions, substitutions, and changes in the form of the detail of the device illustrated, may be made by those skilled in the art without departing from the spirit of the present invention. Consequently, the scope of the invention should not be limited to the foregoing discussion, but is to be defined by the appended claims.